UNITED STATES SIGNAL SERVICE

MONTHLY WEATHER REVIEW.

VOL. XVI. WASHINGTON CITY, JUNE, 1888. No. 6.

INTRODUCTION.

This REVIEW treats generally the meteorological conditions of the United States and Canada for June, 1888, and is based upon the reports of regular and voluntary observers of both countries. Descriptions of the storms that occurred over the north Atlantic Ocean are also given, and their approximate paths shown on chart i, on which also appears the distribution of icebergs and field-ice and the limits of fog-belts west of the fortieth meridian. The weather over the north Atlantic was unusually fine, and the depressions traced were deficient both in number and energy when compared with June average.

Over a large part of the country the mean temperature differed but slightly from the normal. The greatest deficiency occurred in the west gulf states and on the middle Pacific coast, and the greatest excess in the southern Rocky Mountain districts, Saint Lawrence Valley, and lower lake region.

The rainfall was largely in excess of the average in the northern districts from Lake Superior westward to the Pacific coast, and in the west Gulf states. It was decidedly below the average in the upper lake region, New England, the south Atlantic states, and in the southern plateau. Elsewhere the departures from the average were not especially marked.

In the preparation of this REVIEW the following data, received up to July 20, 1888, have been used, viz., the regular tri-daily weather-charts, containing data of simultaneous observations taken at 133 Signal Service stations and 22 Canadian stations, as telegraphed to this office; 175 monthly journals and 175 monthly means from the former and 22 monthly means from the latter: 344 monthly registers from voluntary observers; 61 monthly registers from United States Army post surgeons; marine records; international simultaneous observations; marine reports through the co-operation of the Hydrographic Office, United States Navy, and the "New York Herald Weather Service;" monthly weather reports from the local weather services of Alabama, Arkansas, Colorado, Illinois, Indiana, Kansas, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New England, New Jersey, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Tennessee, and Texas, and the Central Pacific Railway Company; trustworthy newspaper extracts, and special reports.

ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean pressure for June, 1888, determined from tri-daily telegraphic observations of the Signal Service, is shown by isobarometric lines on chart ii.

An area of low mean pressure extends from Arizona and New Mexico north-northeastward to the British Possessions, within which area the barometric means range between 29.72 and 29.80, except over portions of Arizona and New Mexico, where the mean pressure slightly exceeds 29.8. It will be seen from the chart that this isobar of 29.8, showing the region last referred to, is inclosed by the isobar of 29.75, indicating a slight increase of pressure near the centre of the southern portion of the extended area of low mean pressure. To the eastward of the area of least pressure the barometric means increase gradually over the southern districts to 30.0, or slightly above, in the south Atlantic states, the difference between the means over the northern districts from the Rocky Mountains to New England being somewhat less marked. Westward of the area of minimum mean pressure to the Pacific coast the increase of pressure in proportion to the distance is about the same as to the eastward, the highest mean pressure, 29.96, occurring at San Francisco, Cal.

The departures from the normal pressure at the various Signal Service stations are given in the table of miscellaneous meteorological data. Throughout the United States and the adjacent portions of the British Possessions the mean pressure for June is below the normal, the departures being most marked from the Red River Valley of the North westward to the Pacific coast, where they range from .10 to .16, and least in California, where the pressure is nearly normal. East of the Mississippi the departures are less than .05, except along the Atlantic coast from Virginia northward, where they slightly exceed .05. Over the southwestern portions of the country the pressure ranges from .05 to .09 below the normal.

Compared with the mean pressure of the preceding month, a very slight increase is shown over the central Mississippi valley and Southern States, while in all other districts the pressure for June is lower than that of May, the difference being greatest in the extreme northwest and northern Rocky Mountain slope, where it amounts to from .15 to .20.

BAROMETRIC RANGES.

The monthly barometric ranges at the various Signal Service stations are also given in the table of miscellaneous meteorological data. The monthly ranges are greatest in the extreme northwest and upper Missouri valley, where they exceed 1.00, the maximum, 1.21, occurring at Fort Totten, Dak.; they were, as usual, least along the Gulf and south Pacific coasts, where they were .40 or less, the least, .25, occurring at Key West, Fla. For the states bordering on the Atlantic the extreme ranges are .25 at Key West, Fla., and .73 at Portland, Me.; between the eightieth and ninetieth meridians, .41 at Cedar Keys, Fla., and .79 at Alpena, Mich.; between ninetieth and one hundredth meridians, .33 at Brownsville and Rio Grande City, Tex., and 1.21 at Fort Totten, Dak.; eastern slope of Rocky Mountains, .43 at Fort Davis, Tex., and .95 at Poplar River, Mont.; plateau region, .33 at Yuma, Ariz., and .71 at Salt Lake City, Utah; Pacific coast, .27 at San Diego, Cal., and .88 at Tatoosh Island, Wash.

AREAS OF HIGH PRESSURE.

Six areas of high pressure were observed within or near the limits of the stations of observation during the month of June, three of which first appeared on the north Pacific coast and were traced to the Atlantic, the general direction of movement being slightly to the south of east. Two areas of high pressure were first observed near the centre of the continent, in the region west of Hudson Bay, and moved in a southeasterly direction, one reaching the south Atlantic coast and the other disappearing in the Saint Lawrence Valley. The month closed with an area of high pressure on the north Pacific coast, apparently moving northward, following the coast.

The following table shows the approximate latitude and longitude in which the centre of each area of high pressure was first and last observed, the highest observed barometer reading attending each, and the average rate of movement in miles per hour:

Number of area.	First observed.		Last observed.		Highest observed barometer reading.	Average hourly movement.
	Lat. N.	Long. W.	Lat. N.	Long. W.		
	° ′	° ′	° ′	° ′	*Inches.*	*Miles.*
I	52 45	100 35	35 30	75 25	30.36	18.8
II	41 20	126 30	35 45	77 30	30.34	25.0
III	44 00	122 00	40 00	64 00	30.26	22.9
IV	49 15	81 40	46 25	75 50	30.10	16.7
V	42 45	127 20	48 00	87 00	30.26	21.0
VI	39 45	126 20	47 35	125 00	30.28	22.6

Average rate of progress, 21.2 miles per hour.

I.—The month opened with this area of high pressure central north of Dakota, the barometer being low along both the Atlantic and Pacific coasts. The pressure increased to the south and east during the 1st and 2d, during which time this area extended over the central valleys, attended by generally fair weather throughout the eastern part of the United States, and was preceded by light rains along the Atlantic coast, except in North Carolina where the local rains were heavy. The southeasterly course of this area continued during the 3d and 4th, preceded by showers along the south Atlantic coast, and on the morning of the 5th it was central in eastern North Carolina, the pressure having increased to its maximum, 30.36, as it approached the coast. It apparently moved southward over the Atlantic on the 6th, and the pressure slowly diminished. When this area was observed near the centre of the continent it was inclosed by an isobar of 30.1, and when it reached the south Atlantic coast the bounding was isobar 30.3.

II.—The tri-daily telegraph reports of the 4th indicated the advance of a high area from the north Pacific to the northeastward, the pressure over the Rocky Mountain region being from .3 to .4 below the normal. By the morning of the 5th the pressure had increased from .5 to .7 in twenty-four hours over the northern Rocky Mountain region, when the centre of this area was north of Montana. At this point the direction of movement changed, and after passing over the upper Missouri valley it moved directly east during the 6th and 7th, when it extended over the upper lake region, the pressure increasing during the easterly movement, and reaching a maximum of 30.34 at Marquette, Mich., at the morning report of the latter date, when the centre was near that station. From the upper lake region it moved southeastward, covering the entire Atlantic coast from Maine to Florida, the pressure decreasing with the movement and with its increased area, and it disappeared to the east of the coast line during the 9th.

III.—This was a well marked area of high pressure which was central in Oregon on the morning of the 8th, and moved across the continent with an almost uniform velocity of twenty-three miles per hour, occupying five days in making the transit from the Pacific to the Atlantic coast. During the first twenty-four hours there was an apparent tendency to follow a northeasterly course. It was central in southern Montana on the 9th, and extended over the central valleys during the 10th and 11th, inclining to the southeastward until the centre reached the Mississippi Valley, after which the movement was directly to the east, with increasing pressure at the centre. The maximum pressure, 30.26, was observed on the New England and middle Atlantic coasts on the 13th, when the centre was near, and to the east of, the coast line. It disappeared during the 14th, apparently moving in an easterly direction, but leaving the pressure above the normal over the south Atlantic states.

IV.—The barometer continued generally below the normal over the northern portions of the United States from the 15th to 18th, when a ridge of relatively high pressure formed between storms which were central in the lower Saint Lawrence and upper Missouri valleys, respectively. This distribution of pressure became more marked during the 18th, and the high pressure was apparently re-enforced from the Hudson Bay region. On the morning of the 19th this area was central over the Saint Lawrence Valley. It developed but little energy and caused no marked changes in the weather conditions within the United States, and disappeared on the 19th. The maximum pressure for this area was 30.1, at Rockliffe, Ont., on the morning of the 18th.

V.—This area of high pressure extended over the north Pacific coast and California on the 20th, the centre being apparently to the west of Oregon. It extended over the plateau regions during that day while the centre moved northward to Washington Territory, where it was located on the morning of the 21st. It probably passed northward beyond the limit of the chart, but on the succeeding day, the 23d, it was probably observed central north of Montana, from which region the movement was to the eastward north of the stations of observation. It was approximately located as central north of Manitoba on the 25th, and north of, and near, Lake Superior on the 26th, and during the three succeeding days it moved slowly to the southeastward, reaching the New England coast on the 28th, after which it was apparently re-enforced from the westward, and the centre of greatest pressure was transferred to the upper lake region and Ohio Valley. The maximum pressure, 30.26, was observed at stations in the Saint Lawrence Valley and on the New England coast, when the centre was located over New England on the 28th.

VI.—This area was apparently advancing northward along the coasts of California and Oregon on the 30th, the centre remaining to the west of the coast line and being near the mouth of the Columbia River at midnight of the 30th. The pressure increased .2 at Portland, Oregon, during the twenty-four hours ending with the afternoon of the 29th. The maximum pressure, 30.28, occurred on the 30th at three stations on the north Pacific coast. The history of the subsequent movements of this area will be given in the REVIEW for July.

AREAS OF LOW PRESSURE.

The following table shows the latitude and longitude in which each area of low pressure was first and last observed, the lowest pressure observed within each area, and the average velocity in miles per hour:

Number of area.	First observed.		Last observed.		Lowest observed barometer reading.	Average hourly velocity.
	Lat. N.	Long. W.	Lat. N.	Long. W.		
	° ′	° ′	° ′	° ′	*Inches.*	*Miles.*
I	41 20	71 30	49 40	59 15	29.56	41.7
II	50 00	127 00	47 25	72 00	29.24	20.7
IIa	39 30	111 45	39 00	101 40	.....	15.4
III	41 50	116 20	48 30	66 00	29.36	21.5
IV	51 10	111 15	52 00	100 45	29.36	18.8
V	54 00	115 00	47 00	60 00	29.02	29.2
VI	48 00	126 00	54 30	97 00	29.36	37.5
VII	40 00	116 00	53 00	93 00	29.06	10.5
VIII	43 30	78 00	44 30	60 00	29.60	16.1
IX	39 15	107 30	37 35	74 00	29.60	22.2
X	42 00	115 00	41 50	103 10	29.48	9.7
XI	46 30	72 45	43 00	68 15	29.68	52.0

Average rate of progress, 24.6 miles per hour.

Chart i exhibits the tracks of the centres of the areas of low pressure which were observed during the month of June and

shows an abnormal distribution of these disturbances, a number of which either developed within the Rocky Mountain region or remained almost stationary in that region for several days previous to their disappearance to the northward, without passing to the east of the Mississippi Valley. Of the eleven areas of low pressure traced on the chart, three reached the Atlantic coast, passing to the north of the Ohio Valley; three minor disturbances developed in the northeast portions of the United States; and two were traced from the north Pacific eastward, passing northward of the boundary line and causing but slight changes in the weather conditions within the United States.

The following are general descriptions of the weather conditions attending each area of low pressure, with the general directions of movement while within the limits of the stations of observation:

I.—The month opened with the pressure abnormally low on the Atlantic coast, with indications that a disturbance was forming off the middle Atlantic coast. During the succeeding twenty-four hours this disturbance moved northward to the lower Saint Lawrence valley and thence to the northeastward, without unusual energy, although the wind reached a velocity of thirty-six miles per hour at Father Point, Quebec, when the centre was near that station at midnight of the 1st. The barometer remained almost stationary during the north and northeasterly movement, and the depression apparently increased in area during the 2d, when it disappeared to the eastward. The lowest observed barometer reading, 29.56, was noted at Block Island, R. I., on the morning of the 1st.

II and II *a*.—This storm was central on the morning of the 1st northwest of Washington Territory and it moved slowly eastward during the first three days of the month, extending southward and including the plateau and Rocky Mountain regions within its limits. A secondary disturbance formed over Utah to the south of the centre of the principal disturbance during the 3d, and after moving eastward joined the main centre in the upper Missouri valley on the morning of the 4th. The barometer fell from 29.79 to 29.24 during the passage of the centre of this area from the Pacific coast to northern Dakota, and general rains occurred as far south as central California and over the northern and central Rocky Mountain and plateau regions, with light snows in northern Montana. During the 4th an extended trough of low pressure covered the eastern slope of the Rocky Mountains while the centre of the disturbance moved eastward toward Lake Superior. A secondary disturbance which formed in the southern portion of this low pressure was replaced on the 5th by an area of high pressure which extended over the Missouri Valley. This storm reached its maximum energy while central in Dakota, and after passing to the east of that region the pressure at the centre increased and it disappeared as a cyclonic disturbance while central over the Saint Lawrence Valley. Strong winds were reported in the lower lake region and on the New Jersey and southern New England coasts, the maximum velocity reaching 40 miles per hour on the afternoon of the 6th, when the disturbance was near Montreal, Quebec. This storm was within the limits of observation during six days, the centre being approximately located at each telegraphic report during that period. It passed over fifty-five degrees of longitude, and the pressure at the centre was approximately the same, 29.79, when it disappeared as it was when first observed, but during the transit near the central portion of the track it had declined to 29.24.

III.—This depression covered the plateau regions from Arizona to Washington Territory on the 6th. It moved slowly eastward, attended by light rains on the Pacific coast north of San Francisco on the 6th and 7th, and these rains extended eastward over the northern and central Rocky Mountain stations as the centre of disturbance passed over Utah and Wyoming territories. The minimum pressure attending this disturbance, 29.36, was observed at Denver, Colo., at midnight of 7th when the centre was near that station. This disturbance covered the entire eastern slope of the Rocky Mountains and central valleys during the 8th, attended by rain, which was unusually heavy in northern Minnesota and eastern Dakota, at stations north of the centre of disturbance. Heavy local rains and severe local storms also occurred in the Mississippi and Missouri valleys and upper lake region during the 9th while the centre of disturbance was moving slowly from Minnesota to northern Wisconsin. After passing over the Lake region the winds shifted to westerly with increasing force at Lake stations, a maximum velocity of 40 miles occurring at Port Huron, when the centre of disturbance was near Rockliffe, Ontario. It was attended by general showers in the Northern States while it passed over the Saint Lawrence Valley and northern New England, but the strongest winds attending it occurred in the Lake region. The pressure within this disturbance oscillated, there being two periods of barometric minima, the pressure declining while the centre was passing from Nevada to eastern Colorado, and from the upper lake region to the lower Saint Lawrence valley.

IV, V, and VI.—These were minor disturbances which possibly originated on the north Pacific coast and passed to the region north of Montana between the 10th and 16th. The centres of these disturbances have only been approximately located on chart i, and they disappeared to the northward of the Lake region, attended by local rains, however, in the northwestern states and in the Lake region, but producing no marked changes in the weather conditions in the remaining portions of the country. An extended trough of low pressure covered the eastern slope of the Rocky Mountains after low area vi passed to the north of Minnesota, but this was replaced by a gradual increase of pressure over the central valleys on the morning of the 17th.

VII.—This disturbance originated over the plateau region, where it apparently formed during the 16th, central in Nevada but extending from Arizona to British Columbia. It moved northeastward from Nevada to British America north of Montana, the barometer at the centre falling from 29.54 to 29.26. It extended eastward, covering the eastern slope of the Rocky Mountains and Mississippi Valley, remaining almost stationary from the 18th to the 22d, attended by severe storms and heavy local rains from the west Gulf coast northward to Lake Superior, Minnesota, and Dakota. Secondary disturbances formed in the southern portion of this depression and disappeared quickly after the principal centre moved north of Dakota. On the morning of the 21st the minimum pressure, 29.06, was observed in northern Dakota. The depression was almost circular in form and well defined, being bounded by isobars of 29.1, 29.2, 29.3, 29.4, 29.5, and 29.6, covering the region from Lake Superior to central Montana, and from the northern boundary southward to central Nebraska. The disturbance moved northeastward from Dakota and was last observed on the morning of the 23d, the centre being far to the north of Lake Superior. The continued southerly winds and high temperature which attended this disturbance in the districts east of the Mississippi were followed by numerous local rains from the Lake region southward to the Gulf coast. When this storm was central north of Dakota on the 22d a second low area appeared in the lower Saint Lawrence valley and moved slowly eastward during the 22d and 23d, leaving a slight secondary disturbance over northern New England which was attended by dangerous winds of short duration from Block Island to Eastport on the night of the 23d.

VIII.—The disturbance last named left the pressure over the northern and eastern portions of the United States about .2 below the normal, the pressure being greatest east of New England and in the Mississippi Valley. This disturbance formed over the middle Atlantic states, central in New York on the 24th, causing severe local storms in New England and New York. It was at no time clearly defined as a barometric depression, but from the tri-daily reports the general movement of the centre was to the northward, crossing the lower Saint Lawrence valley and afterwards moving southeastward

over northern New England and Nova Scotia, disappearing to the eastward on the 27th.

IX.—This storm is the only one of the month which passed over the central portion of the United States. It was located as central in Colorado at midnight of the 25th and passed directly eastward, causing very heavy rains in the central valleys on the 26th and 27th. Severe local storms were reported in the Gulf States on the last-named date, with dangerous winds on the Gulf coast, which were apparently due to a secondary disturbance which formed in the lower Mississippi valley on the 26th, but which disappeared by a gradual increase of pressure after the centre of the principal disturbance reached the Ohio Valley. General rains occurred throughout the Southern and Northern States during the passage of this disturbance. On the afternoon of the 28th numerous local storms were reported in the middle Atlantic states, Ohio Valley, and southern New England. Minor depressions were formed near Lake Erie, in eastern Virginia, and in the upper Ohio valley. Rain continued on the middle Atlantic and New England coasts on the 29th, attended by strong northeasterly winds, which reached a maximum velocities of forty-four miles per hour at Sandy Hook, forty miles at Block Island, and thirty-five miles at Atlantic City. The centre of this disturbance was last observed off the middle Atlantic coast on the 29th.

X.—Number x formed over the central plateau region on the 27th, and after moving to the central Rocky Mountain region apparently receded to the westward, after which it developed energy and moved in a northeasterly direction over Wyoming, and on the last day of the month it extended over the slope of the Rocky Mountains as a trough of low pressure, the centre being in western Nebraska.

XI.—This disturbance apparently approached the lower Saint Lawrence valley from the Hudson Bay region. The pressure decreased at the northeastern Canadian stations on the night of the 29th, and on the afternoon of the 30th there was a well-defined low area central in the Saint Lawrence Valley near Quebec. It passed southeastward over New England, and at midnight of the 30th general rains prevailed on the New England coast and dangerous winds occurred on the southern New England coast, the centre of disturbance being east of Portland and south of Eastport, Me. Between the afternoon and midnight of the 30th a maximum velocity of fifty miles per hour occurred at Block Island, R I.

NORTH ATLANTIC STORMS FOR JUNE, 1888.

[*Pressure in inches and millimetres; wind-force by Beaufort scale.*]

The paths of the depressions that appeared over the north Atlantic Ocean during June, 1888, have been determined from international simultaneous observations by captains of ocean steamships and sailing vessels, received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Nine depressions have been traced, of which six advanced eastward over or near Newfoundland; one first appeared north of the Azores; one apparently moved southeastward from Greenland; and one originated off the southern edge of the Banks of Newfoundland. The depressions generally pursued normal east-northeast tracks, with a rather slow rate of progression.

The month opened with moderate to fresh gales over the entire ocean, attending the presence of two areas of low pressure located, respectively, to the northward of the Azores and on the middle Atlantic coast of the United States; over the southern portion of the British Isles the barometer was relatively high. From the 2d to the 4th, inclusive, the weather conditions continued unsettled, after which there was an apparent west to east translation of high barometric pressure until the 10th. From the 11th to the 14th fresh to strong gales prevailed from Newfoundland to the British Isles, which conditions were succeeded by an area of high pressure which extended eastward from the American coast during the 15th and 16th. During the balance of the second decade the barometer continued high east of the twentieth meridian, while in the vicinity of Newfoundland and the Grand Banks storms of moderate strength were encountered. From the 20th to the 25th generally fair weather prevailed over the British Isles; to the westward of the twentieth meridian this period was marked by fresh increasing to strong gales, and low barometric pressure. Subsequent to the 25th the winds were cyclonic off the west-central coast of Europe, attending the slow eastward passage of an area of low pressure. Over the ocean west of the thirtieth meridian the severest storms of the month occurred from the 26th to the 30th, inclusive, when barometer readings ranging to about 29.20 (741.7) were reported off the northeast edge of the Banks of Newfoundland.

In June, 1887, thirteen depressions were traced, of which one traversed the ocean from coast to coast; two appeared to the northward of the West Indies; two passed eastward over Newfoundland; one apparently originated southwest of the British Isles and moved northward; and eight developed over mid-ocean. The progressive movement of the depressions was northeastward east of the thirtieth meridian, while to the westward of that longitude their course of direction was irregular. With the exception of rather strong summer gales to the westward of the twenty-fifth meridian during the second decade of the month, the general character of the weather over the north Atlantic was settled and seasonable. The lowest barometric reading reported in the trans-Atlantic routes was 29.30 (744.2), on the 15th, in N. 42° 53′ W. 57° 31′.

As compared with the corresponding month of previous years, the general character of the weather over the north Atlantic Ocean during June, 1888, was seasonable. The depressions which appeared were deficient in number, and storms of marked strength were not reported save during the last few days of the month. The development of storms in the tropical or subtropical regions of the West Indies and the Gulf of Mexico was not indicated.

In the following descriptions of the depressions traced positions are given in degrees, latitude and longitude, except in cases where twenty-five to thirty-five minutes are cited, when they are shown in degrees and half degrees:

1.—This storm was a continuation of depression number 11 traced for May, 1888, and was central June 1st in about N. 44°, W. 30°, with pressure falling below 29.40 (746.7), and fresh to strong gales; by the 3d the storm-centre had advanced northeast to the twentieth meridian, with an appreciable diminution in energy, after which it recurved southeastward, and disappeared in the direction of the Bay of Biscay after the 4th.

2.—This depression apparently originated off the middle Atlantic coast of the United States during the 2d, whence it moved northeast to N. 41°, W. 63° by the 3d, with pressure about 29.80 (756.9); by the 4th the centre of depression had passed north-northeast to Newfoundland, and thence moved eastward to the forty-second meridian by the 5th. During the next three days the depression pursued a course to the southern extremity of Ireland, where it was central on the 8th, attended by a gradual decrease in barometric pressure, and moderate to fresh gales, after which it disappeared beyond the region of observation.

3.—This depression was a continuation of land low area number i which passed eastward over the Gulf of Saint Lawrence and Newfoundland during the 2d; on the 3d the storm was central in N. 50°, W. 43°, whence it advanced to N. 51°,